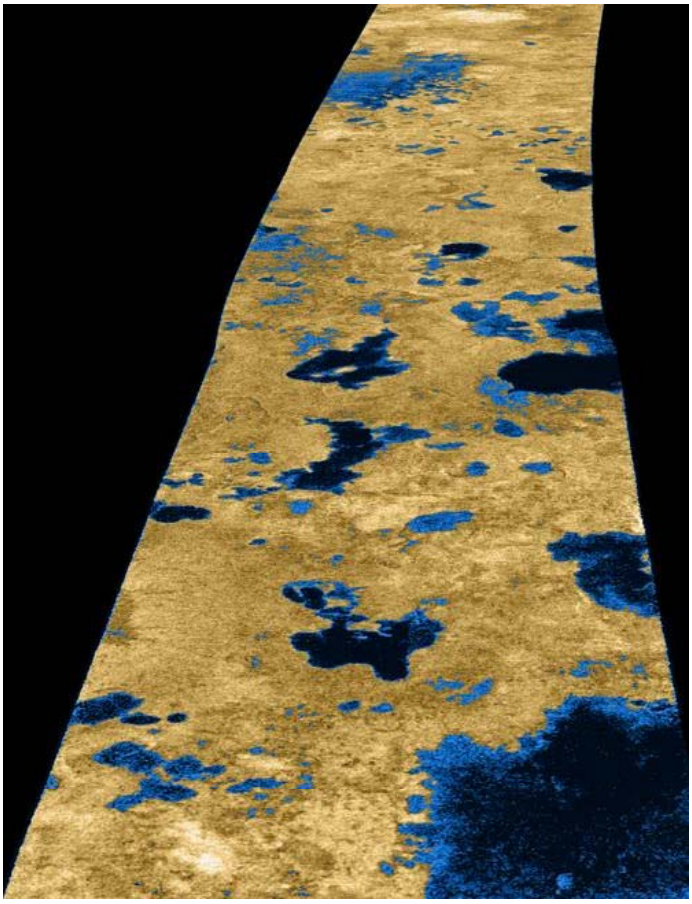
C A S S I N I



T I T A N **0 4 2 T I (T 2 8)** MISSION DESCRIPTION

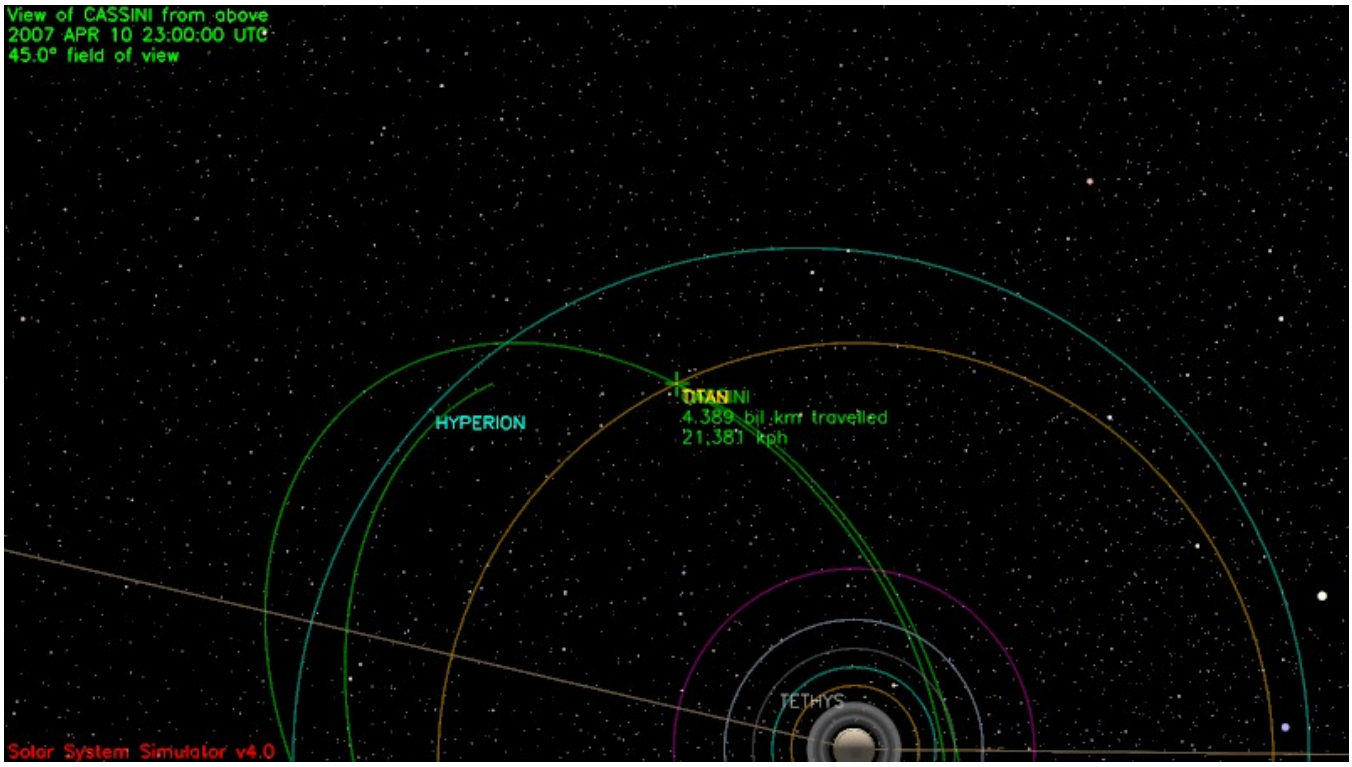
April 2007

Jet Propulsion Laboratory
California Institute of Technology

1.0 OVERVIEW

A mere 15 days after Titan-27, Cassini returns to Titan for its twenty-ninth targeted encounter. The closest approach to Titan occurs on Tuesday, April 10, at 2007-100T22:58 spacecraft time at an altitude of 990 kilometers (~614 miles) above the surface and at a speed of 6.2 kilometers per second (13,870 mph). The latitude at closest approach is 50.4 degrees N and the encounter occurs on orbit number 42.

This encounter is set up with two maneuvers: an apoapsis maneuver on April 2, and a Titan approach maneuver, scheduled for April 7. This is the fourth in a series of outbound Titan encounters (until T34), and occurs about two days after Saturn closest approach.



1.1 ABOUT TITAN

If Titan were a planet, it would likely stand out as the most important planet in the solar system for humans to explore. Titan, the size of a terrestrial planet, has a dense atmosphere of nitrogen and methane and a surface covered with organic material. It is Titan that is arguably Earth's sister world and the Cassini-Huygens mission considers Titan among its highest priorities.

Although it is far colder and lacks liquid water, the chemical composition of Titan's atmosphere resembles that of early Earth. This, along with the organic chemistry that takes place in Titan's atmosphere, prompts scientists to believe that Titan could provide a laboratory for seeking insight into the origins of life on Earth. Data from the Huygens probe, which touched down on Titan's surface in January 2005, and the Cassini orbiter has shown that many of the processes that occur on Earth also apparently take place on Titan – wind, rain, volcanism, tectonic activity, as well as river channels, and drainage patterns all seem to contribute in shaping Titan's surface. However, at an inhospitable -290 degrees Fahrenheit (-179 degrees Celsius), the chemistry that drives these processes is fundamentally different from Earth's. For example it is methane that performs many of the same functions on Titan that water does on Earth.

The Huygens probe landed near a bright region now called Adiri, and photographed light hills with dark river beds that empty into a dark plain. It was believed that this dark plain could be a lake or at least a muddy material, but it is now known that Huygens landed in the dark region, and it is solid. Scientists believe it only rains occasionally on Titan, but the rains are extremely fierce when they come.

Only a small number of impact craters have been discovered. This suggests that Titan's surface is constantly being resurfaced by a fluid mixture of water and possibly ammonia, believed to be expelled from volcanoes and hot springs. Some surface features, such as lobate flows, appear to be volcanic structures. Volcanism is now believed to be a significant source of methane in Titan's atmosphere. However, there are no oceans of hydrocarbons as previously hypothesized. Dunes cover large areas of the surface.

The existence of oceans or lakes of liquid methane on Saturn's moon Titan was predicted more than 20 years ago. Radar and imaging data from Titan flybys have provided convincing evidence for large bodies of liquid. With Titan's colder temperatures and hydrocarbon-rich atmosphere, these lakes and seas most likely contain a combination of liquid methane and ethane (both hydrocarbons), not water.

The Cassini-Huygens mission, using wavelengths ranging from ultraviolet to radio, is methodically and consistently revealing Titan and answering long-held questions regarding Titan's interior, surface, atmosphere, and the complex interaction with Saturn's magnetosphere. While many pieces of the puzzle are yet to be found, with each Titan flyby comes a new data set that furthers our understanding of this world as we attempt to constrain scenarios for the formation and evolution of Titan and its atmosphere.

1.2 TITAN-28 SCIENCE HIGHLIGHTS

- RADAR: The T25 encounter revealed a fascinating feature: an island, smack dab in the middle of one of one of Titan's larger lakes. The T28 flyby will give the RADAR team another scatterometry look at that island from a slightly different viewpoint, crossing over previous scatterometry tracks. Using the newer and older data sets, RADAR will be able to produce stereo images of the region. There's a possibility of seeing some changes over the few months since the last view of the area, but that's not expected.
- ISS: The T28 flyby will show a region we haven't seen since approach in April of 2004. Now Cassini will see that area repeatedly, allowing us to examine how frequently clouds form in the area, and if their shapes (morphologies) are different than those seen elsewhere on Titan. ISS will use both regional and global-scale mosaics to monitor for changes on the surface and in the atmosphere, as well as attempt to see surface color variations.
- CIRS: CIRS continues global far-infrared observations at high northern latitudes. These high spectral resolution measurements are used to measure global distributions of hydrocarbons, nitriles, water, and CO, and to see how these distributions vary with latitude. But that's not all: the CIRS observations also search for new (chemical) species concentrated at the poles. High spectral resolution limb integrations are valuable for detecting weak species (including isotopes) and measuring the global abundances thereof, by virtue of long atmospheric path lengths.
- UVIS: Spectral atmospheric mosaic across Titan.
- VIMS: Inbound, VIMS will make cloud mapping observations. On the outbound part of the flyby, VIMS will capture high-resolution surface observations.

1.3 SAMPLE SNAPSHOTS

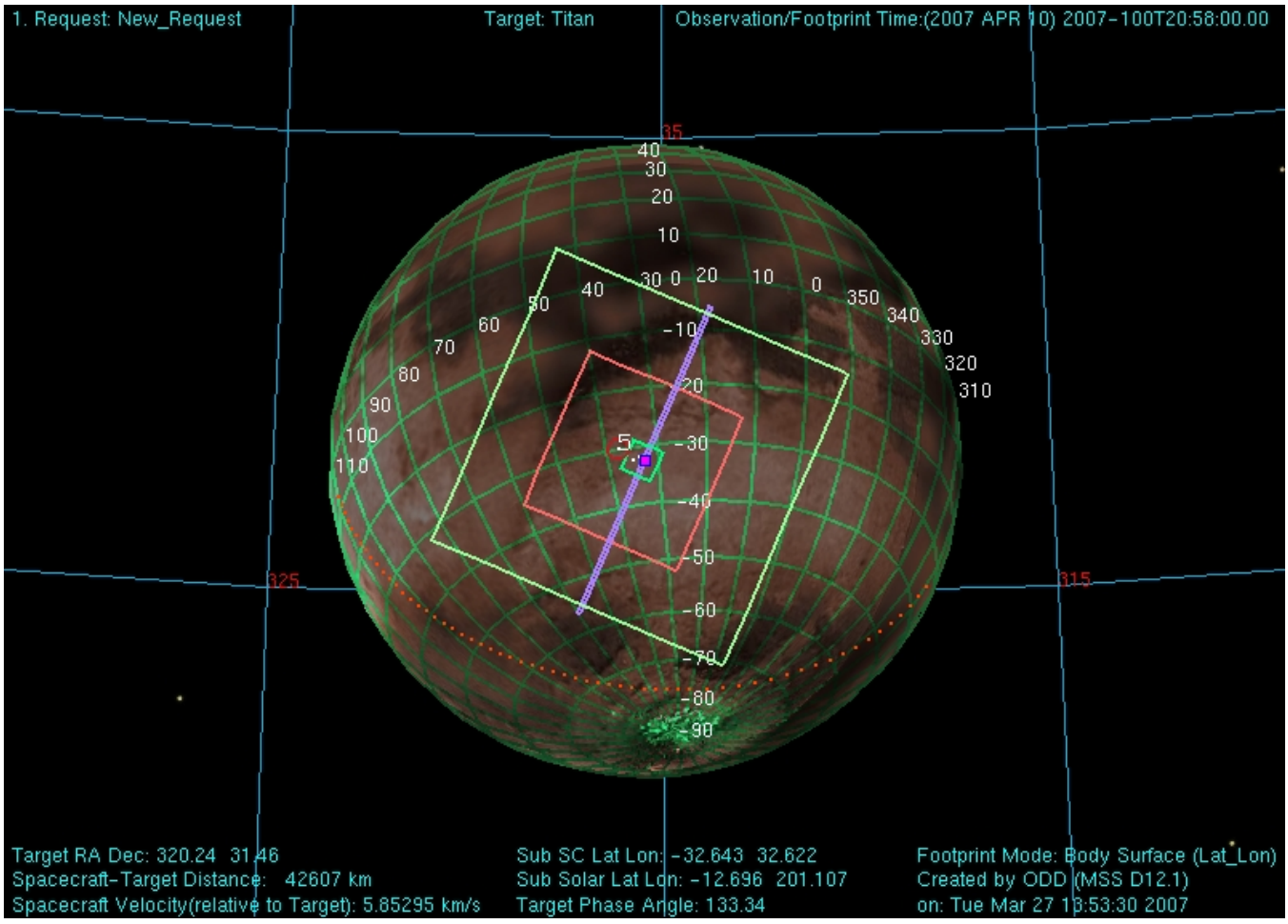
Three views of Titan from Cassini before, during, and after closest approach to Titan are shown below. The views are oriented such that the direction towards the top of the page is aligned with the Titan North Pole. The optical remote sensing instruments' fields of view are shown assuming they are pointed towards the center of Titan. The sizes of these fields of view vary as a function of the distance between Cassini and Titan. A key for use in

identifying the remote sensing instruments fields of view in the figures is listed at the top of the next page.

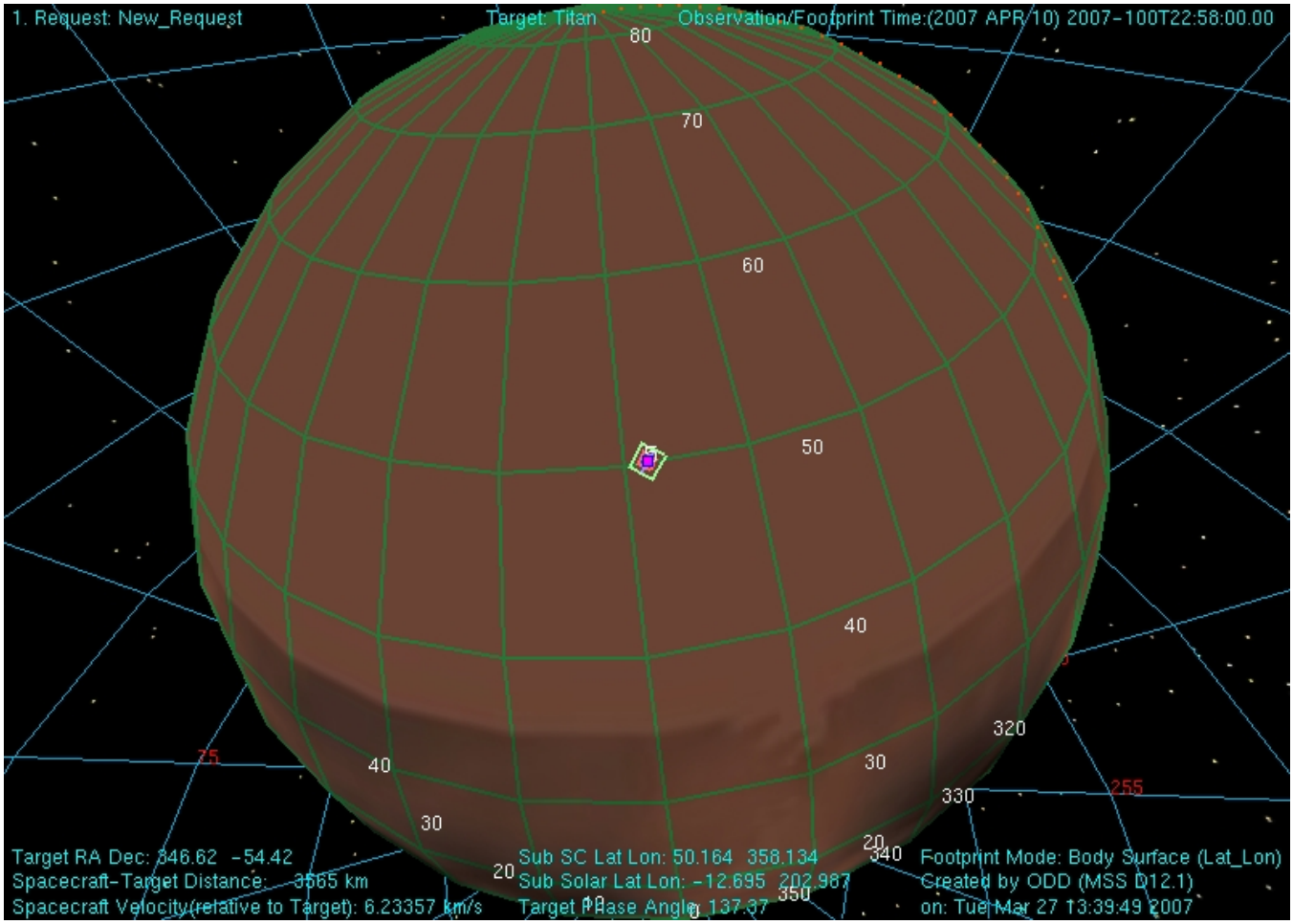
Key to ORS Instrument Fields of View in Figures

Instrument Field of View	Depiction in Figure
ISS WAC (imaging wide angle camera)	Largest square
VIMS (visual and infrared mapping spectrometer)	Next largest pink square
ISS NAC (imaging narrow angle camera)	Smallest green square
CIRS (composite infrared spectrometer) – Focal Plane 1	Small red circle near ISS_NAC FOV
UVIS (ultraviolet imaging spectrometer)	Vertical purple rectangle centered within largest square

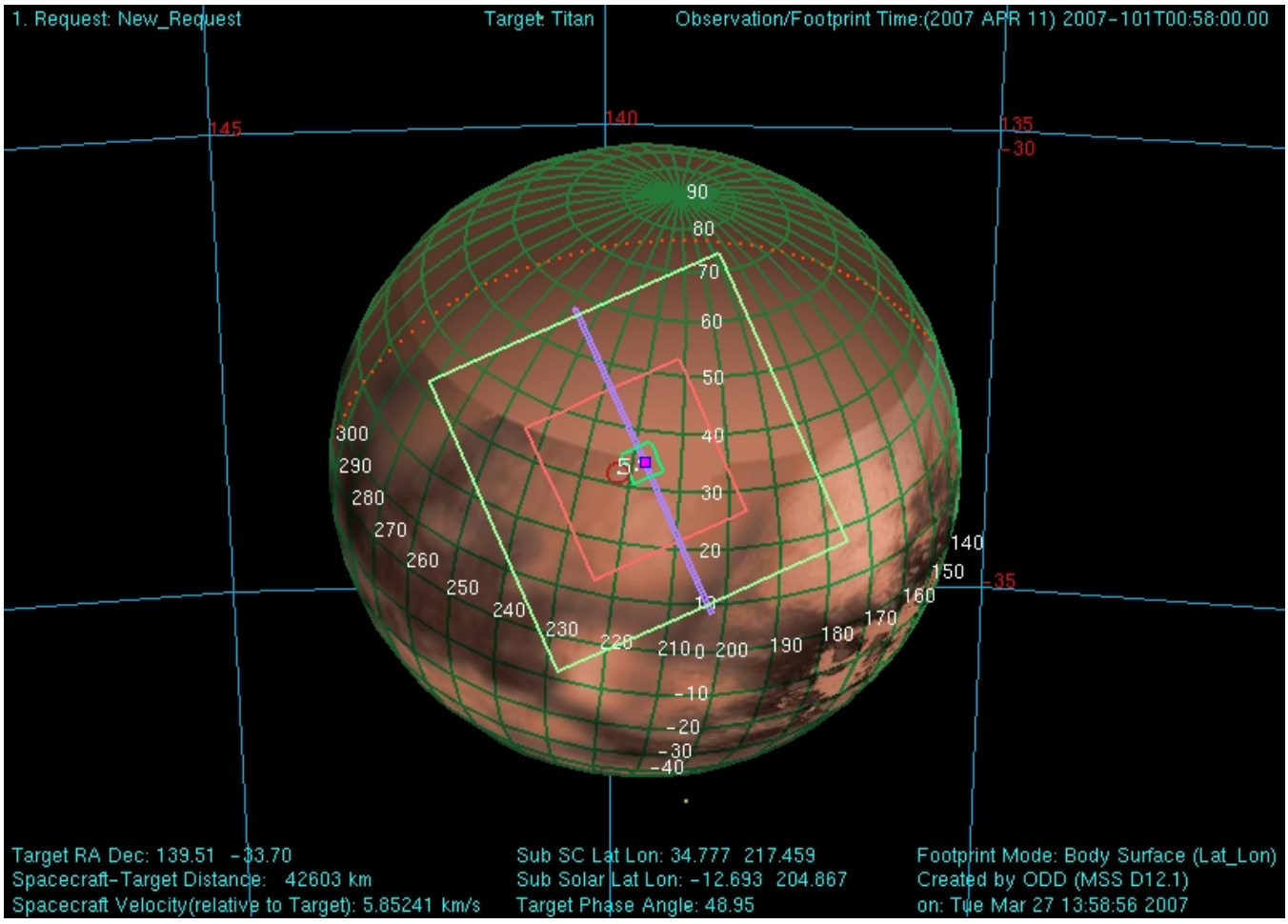
View of Titan from Cassini two hours before Titan-28 closest approach



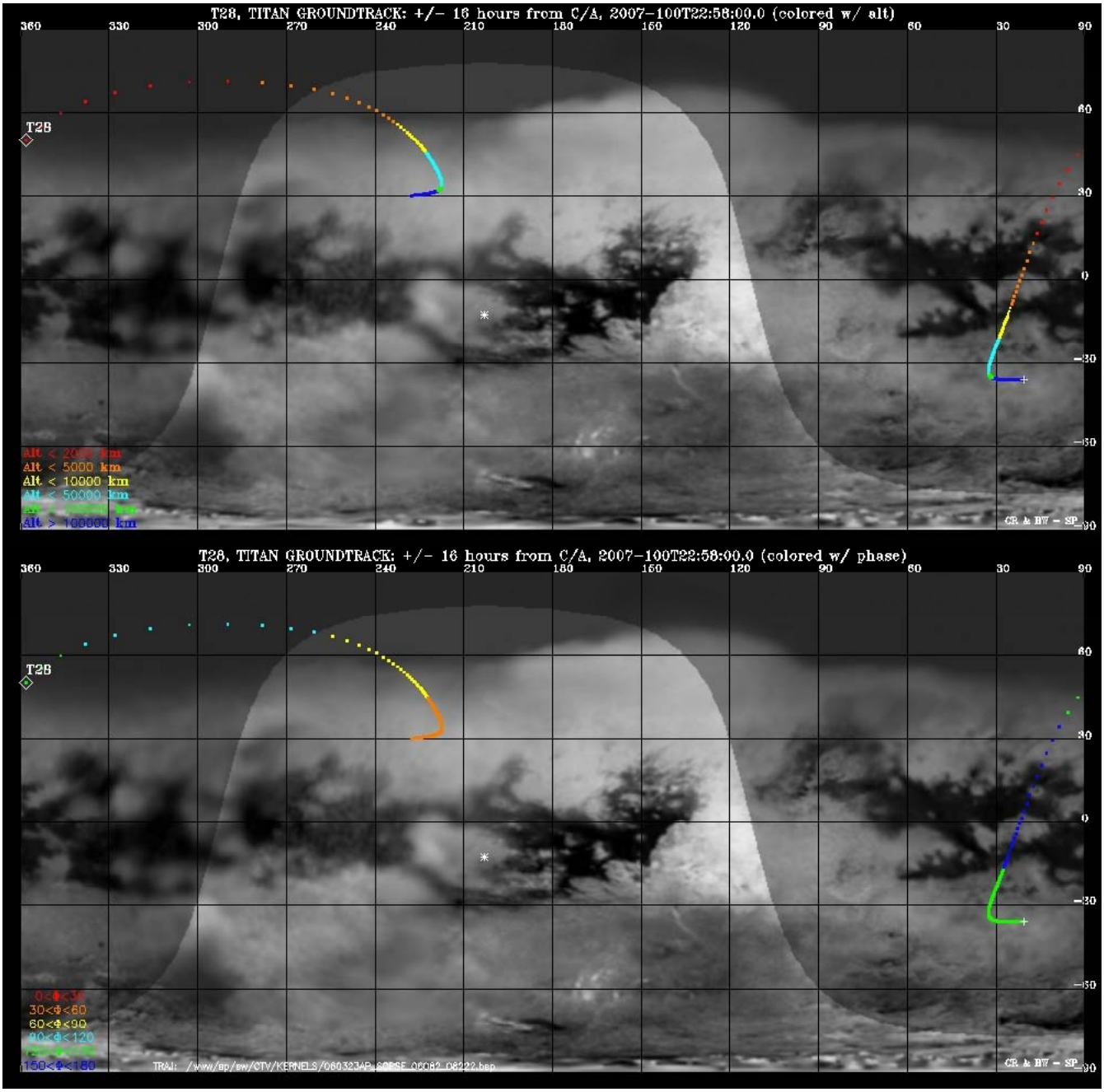
View of Titan from Cassini at Titan-28 closest approach



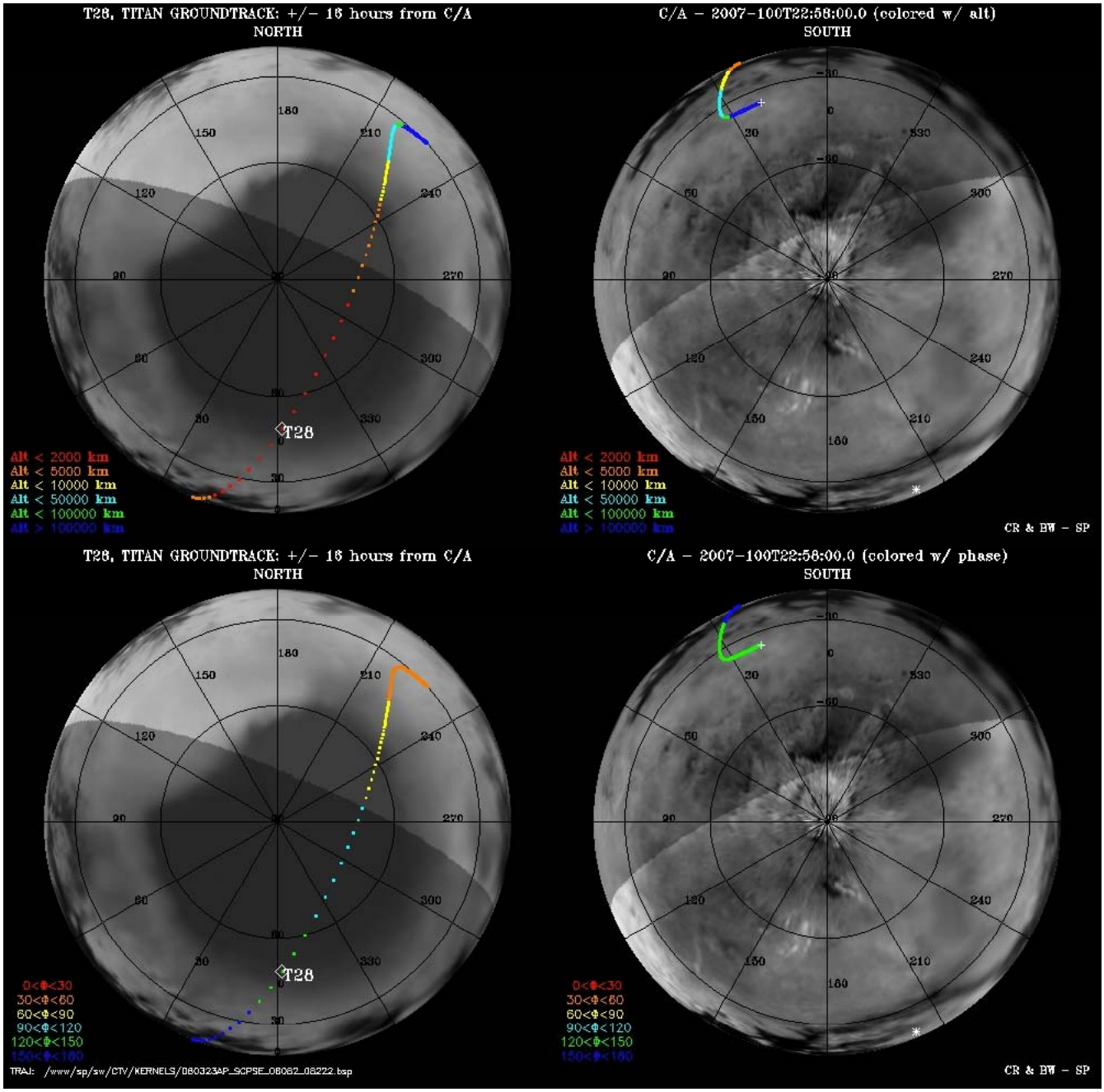
View of Titan from Cassini two hours after Titan-28 closest approach



Titan Groundtracks for T28: Global Plot



Titan Groundtracks for T28: Polar Plot



The T28 timeline is as follows:

Cassini Titan-28 Timeline - April 2007

Colors: yellow = maneuvers; blue = geometry; pink = T27-related; green = data playbacks

Orbiter UTC	Ground UTC	Pacific Time	Time wrt T28	Activity	Description
087T08:04:00	Mar 28 09:16	Wed Mar 28 01:16 AM	T28-13d15h	Start of Sequence S29	Start of Sequence which contains Titan-28
097T14:48:00	Apr 07 16:00	Sat Apr 07 08:00 AM	T28-03d08h	OTM #103 Prime	Titan-28 targeting maneuver.
098T04:57:29	Apr 08 06:09	Sat Apr 07 10:09 PM	T28-02d18h	Descending Ring Plane Crossing	
098T16:21:34	Apr 08 17:33	Sun Apr 08 09:33 AM	T28-02d07h	Saturn Periapse	Saturn periapse, R = 7.6 Rs, lat = -39 deg, phase = 100 deg
098T22:18:00	Apr 08 23:30	Sun Apr 08 03:30 PM	T28-02d01h	OTM #103 Backup	
100T07:03:00	Apr 10 08:15	Tue Apr 10 12:15 AM	T28-15h55m	Start of the TOST segment	
100T07:03:00	Apr 10 08:15	Tue Apr 10 12:15 AM	T28-15h55m	Turn cameras to Titan	
100T07:33:00	37720.36458	37720.03125	T28-15h25m	Deadtime	16 minutes long; used to accommodate changes in flyby time
100T07:49:00	Apr 10 09:01	Tue Apr 10 01:01 AM	T28-15h09m	ISS Imaging	NAC nightside imaging
100T07:58:00	Apr 10 09:10	Tue Apr 10 01:10 AM	T28-15h00m	Titan atmospheric Observations	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
100T09:58:00	Apr 10 11:10	Tue Apr 10 03:10 AM	T28-13h00m	Titan atmospheric Observations	Cloud Map. Obtain 8 double resolution 64X64 images.
100T13:58:00	Apr 10 15:10	Tue Apr 10 07:10 AM	T28-09h00m	Titan atmospheric Observations	UV mosaic across Titan
100T17:48:00	Apr 10 19:00	Tue Apr 10 11:00 AM	T28-05h10m	New Waypoint	
100T18:08:00	Apr 10 19:20	Tue Apr 10 11:20 AM	T28-04h50m	RADAR Observations	Inbound radiometry of unique terrain at mid latitudes
100T21:43:00	Apr 10 22:55	Tue Apr 10 02:55 PM	T28-01h15m	RADAR Observations	Mid latitude scatterometry of unique terrain coverage of Titan.
100T22:06:00	Apr 10 23:18	Tue Apr 10 03:18 PM	T28-00h52m	Transition to Thruster Control	
100T22:28:00	Apr 10 23:40	Tue Apr 10 03:40 PM	T28-00h30m	RADAR Observations	Altimetry measurements on the inbound leg of the T28 flyby.
100T22:42:00	Apr 10 23:54	Tue Apr 10 03:54 PM	T28-00h16m	RADAR Observations	Low resolution SAR imaging on the inbound leg of T28.
100T22:51:00	Apr 11 00:03	Tue Apr 10 04:03 PM	T28-00h07m	RADAR Observations	High resolution SAR imaging during the T28 closest approach period
100T22:58:00	**Apr 11 00:10**	**Tue Apr 10 04:10 PM**	**T28+00h00m**	**Titan-28 Flyby Closest Approach Time**	**Altitude = 990 km (615 miles), speed = 6.2 km/s (13,870 mph); 137 deg phase at closest approach**
100T23:01:11	Apr 11 00:13	Tue Apr 10 04:13 PM	T28+00h03m	Ascending Ring Plane Crossing	
100T23:05:00	Apr 11 00:17	Tue Apr 10 04:17 PM	T28+00h07m	RADAR Observations	Low resolution SAR imaging on the outbound leg of T28.
100T23:14:00	Apr 11 00:26	Tue Apr 10 04:26 PM	T28+00h16m	RADAR Observations	Altimetry measurements on the outbound leg of the T28 flyby.
100T23:27:00	Apr 11 00:39	Tue Apr 10 04:39 PM	T28+00h29m	New Waypoint	
100T23:58:00	Apr 11 01:10	Tue Apr 10 05:10 PM	T28+01h00m	Titan surface observations	high-resolution cubes of Titan's surface
101T00:58:00	Apr 11 02:10	Tue Apr 10 06:10 PM	T28+02h00m	ISS Imaging	NAC Regional Map
101T02:58:00	Apr 11 04:10	Tue Apr 10 08:10 PM	T28+04h00m	Titan atmospheric Observations	Obtain information on trace constituents in Titan's stratosphere. Integrate on limb at two positions.
101T03:58:00	Apr 11 05:10	Tue Apr 10 09:10 PM	T28+05h00m	ISS Imaging	NAC Global Map
101T07:34:00	Apr 11 08:46	Wed Apr 11 12:46 AM	T28+08h36m	ISS Imaging	WAC Photometry
101T07:58:00	Apr 11 09:10	Wed Apr 11 01:10 AM	T28+09h00m	Titan atmospheric Observations	Obtain information on CO, HCN, CH4. Integrate on disk at airmass 1.5--2.0.
101T12:58:00	Apr 11 14:10	Wed Apr 11 06:10 AM	T28+14h00m	CIRS_042TI_MIDIRTMAP002_PRIME	Obtain information on the thermal structure of Titan's stratosphere. Slew across disk at 4 microrad/s.
101T20:12:00	37721.89167	37721.55833	T28+21h14m	SP_042TI_DEADTIME101_PRIME	15 minutes long; used to accommodate changes in flyby time
101T20:27:00	Apr 11 21:39	Wed Apr 11 01:39 PM	T28+21h29m	Turn to Earth-line	
101T20:57:00	37721.92292	37721.58958	T28+21h59m	Playback of T28 Data	Goldstone 70M